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HISTOLOGICAL GONAD ANALYSES OF LATE SUMMER-EARLY WINTER COLLECTIONS OF BIGEYE TUNA, *Thunnus obesus*, AND YELLOWFIN TUNA, *Thunnus albacares*, FROM THE NORTHWEST ATLANTIC AND THE GULF OF MEXICO

Stephen R. Goldberg
and
Hillary Herring-Dyal

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Stephen R. Goldberg
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National Marine Fisheries Service
Southwest Fisheries Center
La Jolla, California 92038

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
National Oceanic and Atmospheric Administration
Dr. John V. Byrne, Administrator
National Marine Fisheries Service
William H. Stevenson, Acting Assistant Administrator for Fisheries

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Histological gonad analyses of late summer-early winter collections of bigeye tuna, Thunnus obesus, and yellowfin tuna Thunnus albacares, from the Northwest Atlantic and the Gulf of Mexico

Stephen R. Goldberg
Department of Biology
Whittier College
Whittier, California 90608

Hillary Herring-Dyal
Southwest Fisheries Center
National Marine Fisheries Service, NOAA
La Jolla, California 92038

INTRODUCTION

There is little information available on the reproduction of yellowfin and bigeye tuna in the Gulf of Mexico and adjacent Northwest Atlantic Ocean. Previous reproductive studies on samples from the Pacific Ocean (Schaefer and Orange, 1956; Orange, 1961; Yuen, 1955; Yuen and June 1957) provide some information on the spawning of these species. In order to gain an understanding of yellowfin and bigeye tunas' reproductive potential, a histological gonadal analysis was conducted. This analysis will contribute to a more complete picture of the reproductive biology of yellowfin and bigeye tunas.

METHODS

Specimens were collected from the Gulf of Mexico and the Northwest Atlantic Ocean (Figure 1). The collections were made from September 1978 through December 1979 by United States observers aboard Japanese longline vessels fishing in the United States Fishery Conservation Zone.[1] Upon capture, fishes were weighed to the nearest kilogram and measured (fork-length) to the nearest centimeter. A ventral longitudinal incision was made on the abdomen and the paired gonads were removed and placed in a 10% formalin solution.[2] Formalin-preserved gonads were weighed to the nearest gram. A sample from each gonad was embedded in Paraplast.[3] Histological sections were

[1]Samples were obtained from the National Marine Fisheries Service, Southeast Fisheries Center, Miami, Florida.

[2] Fixation in large gonads was not uniform. This problem can be avoided in future samples by making a slit along the length of the gonad with a razor blade. This will facilitate penetration of the fixative.

[3] The use of trade names does not imply endorsement by the U.S. Government.

cut at 8 mm on a rotary microtome, mounted on slides and stained with iron hematoxylin followed by an eosin counterstain. All gonads were histologically classified according to their reproductive stages (Tables 1-2). Gonad weights, gonosomatic indices and statistical analysis for bigeye and yellowfin tuna specimens are given in Appendix A and B respectively.

RESULTS

Females -- Ovaries of all females (collected August through February) were regressed (Tables 1-2) and consisted of primary oocytes arranged along connective tissue septa. There was no vacuolization which typically occurs prior to the beginning of yolk deposition for a new spawning cycle. Also, the almost total absence of follicular atresia, a process in which follicles undergo degeneration, suggests the ovaries had been reproductively inactive for several months. Follicular atresia reaches its highest levels toward the close of the reproductive season when follicles that initiated but did not complete yolk disposition, degenerate. Follicles in various states of atresia remain for some time after reproduction ceases.

Males -- Testes (collected August through February) were primarily regressed (Tables 1-2) as one would expect during a time when no spawning was occurring in the population. There were masses of residual sperm left in several males as is typical in regressed testes. In other cases, limited spermatogenesis was in progress. It is not unusual to find small quantities of sperm formation in males when females are reproductively inactive. However, the level of sperm formation was greatly reduced from what one would have expected during peak spermatogenesis.

DISCUSSION

Although yellowfin tuna and bigeye tuna are reported to spawn most of the year in tropical areas (Yuen, 1955; Yuen and June, 1957) we found no evidence of spawning activity during August through February for yellowfin tuna and September through February for bigeye tuna sampled from the populations under study. Furthermore, the lack of follicular atresia in females during February through September indicates they had not been spawning during the previous 6-8 weeks.

Prior to the onset of spawning, there is typically an increase in oocyte size with a concomitant appearance of vacuoles. One would expect this histological development to occur 8-10 weeks prior to spawning. This was not observed in the samples of either species from December through February and would push the postulated onset of spawning to April through May at the earliest.

It thus appears based on these data, that the populations under study undergo a brief spring spawning period similar to that of northern fishes (Quasim, 1956) which have a restricted spawning season. In order to test our hypothesis of a postulated spring spawning period, it will be necessary to obtain additional female gonads from the period March through June. These additional gonads would be of particular interest in obtaining other valuable information regardless of the reproductive state. Assuming that spawning females were obtained, we could then calculate fecundity estimates, minimum size at sexual maturity, plot a seasonal gonosomatic index graph and obtain

information as to the kind of spawning cycle the populations undergo. For example, are one or two modes of eggs spawned or is a mode of eggs matured and gradually released? If the specimens were reproductively inactive this information would be of interest and perhaps indicate the populations were transitory and migrated into the area after spawning elsewhere. Other factors, such as the possible existence of inadequate nutrition to permit spawning in the study areas and the possibility of environmental pollution inhibiting reproduction, need examining. These are questions that can only be answered by additional collections, especially of spring specimens.

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Table 1. Histological analysis of 158 bigeye tuna gonads, October 1978 through December 1979.

	Female		Male			
Month	N	Regressed	N	Regressed	Recrudescent	Spermatogenesis
October	22	22	0	-----	-----	-----
November	18	18	9	6	0	3
December	57	57	25	19	1	5
September	1	1	0	-----	-----	-----
October	5	5	0	-----	-----	-----
November	8	8	4	4	0	0
December	9	9	0	-----	-----	-----

Table 2. Histological analysis of 106 yellowfin tuna gonads, September 1978 through December 1979.

	Female		Male			
Month	N	Regressed	N	Regressed	Recrudescent	Spermatogenesis
September	3	3	1	0	0	1
October	44	44	0	-----	-----	-----
November	5	5	1	0	0	1
February	3	3	0	-----	-----	-----
August	3	3	1	1	-----	-----
September	9	9	5	3	-----	1
October	18	18	0	-----	-----	-----
November	7	7	4	3	-----	1
December	2	2	0	-----	-----	-----

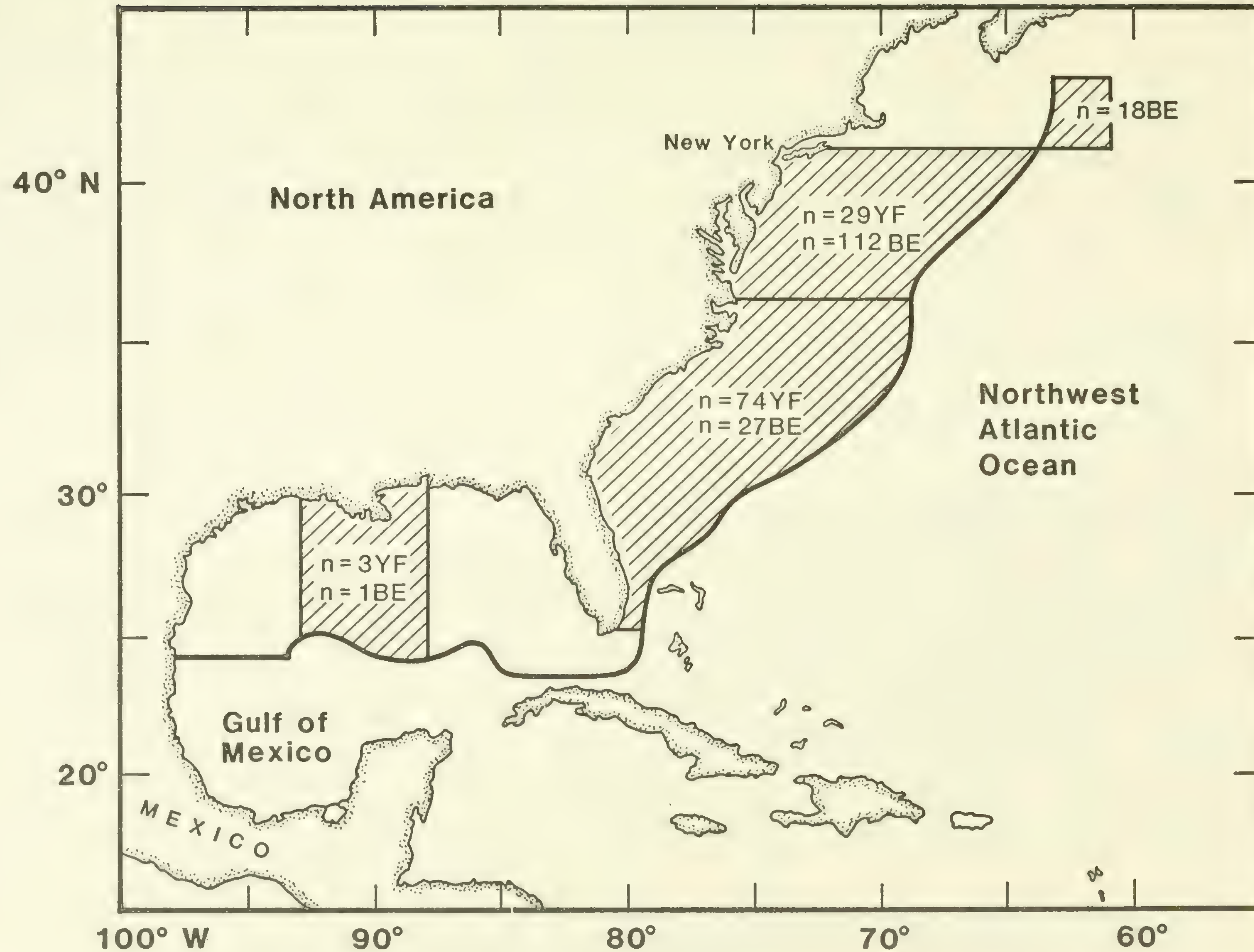

Figure 1. Areas from which specimens were collected.

APPENDIX A. Summary of yellowfin tuna gonad data collected 9/78 through 12/79 in the northwest Atlantic and Gulf of Mexico

Date	Sex	mean fish weight $\bar{X}$	$S\bar{X}$*	mean gonad weight $\bar{Y}$	$S\bar{Y}$*	mean gonad indice $\bar{Z} = \frac{(\frac{\Sigma X}{\Sigma Y})}{n}$	$S\bar{Z}$*	No Samples
9/78	♂	24.0	1.00	67.50	6.8	.28	.04	2
9/78	♀	25.0	2.00	43.00	8.9	.17	.02	2
10/78	♂	-	-	-	-	-	-	0
10/78	♀	24.64	0.55	57.89	3.50	.23	.01	44
11/78	♂	20.00	-	22.6	-	.11	-	1
11/78	♀	23.00	1.58	41.02	8.49	.16	.04	5
2/79	♂	-	-	-	-	-	-	0
2/79	♀	31.00	3.00	152.37	28.90	.48	.05	3
8/79	♂	19.00	-	15.22	-	0.39	-	1
8/79	♀	21.67	0.88	51.16	13.48	0.24	.07	3
9/79	♂	37.00	5.58	42.63	13.59	0.15	.03	5
9/79	♀	25.44	0.38	50.66	4.72	0.20	.02	9
10/79	♂	-	-	-	-	-	-	0
10/79	♀	29.88	2.42	73.64	13.22	0.23	.02	18
11/79	♂	23.75	1.65	11.55	0.85	0.05	.01	4
11/79	♀	26.14	1.35	61.29	9.49	0.23	.03	7
12/79	♂	-	-	-	-	-	-	0
12/79	♀	25.00	5.00	58.02	13.82	0.23	.01	2
TOTAL								106

*S = variance

APPENDIX B. Summary of bigeye tuna gonad data collected 10/78 through 12/79 in the northwest Atlantic and Gulf of Mexico

Date	Sex	mean fish weight $\bar{X}$	$S\bar{X}$*	mean gonad weight $\bar{Y}$	$S\bar{Y}$*	mean gonad indice $\bar{Z} = \frac{(\frac{\Sigma X}{\Sigma Y})}{n}$	$S\bar{Z}$*	No Samples
10/78	♂	-	-	-	-	-	-	0
10/78	♀	36.73	4.32	143.42	20.68	.34	.03	22
11/78	♂	58.44	5.12	37.14	3.72	.07	.01	9
11/78	♀	54.16	2.64	215.64	18.88	.41	.03	18
12/78	♂	35.10	2.46	25.00	3.37	.08	.01	25
12/78	♀	33.19	1.85	119.43	10.87	.33	.02	57
9/79	♂	-	-	-	-	-	-	0
9/79	♀	33.00	-	143.32	-	.43	-	1
10/79	♂	-	-	-	-	-	-	0
10/79	♀	25.60	0.87	74.62	11.59	.29	.03	5
11/79	♂	20.75	4.03	16.46	2.05	.09	.02	4
11/79	♀	30.88	3.36	120.78	20.37	.36	.05	8
12/79	♂	-	-	-	-	-	-	0
12/79	♀	26.11	2.51	72.61	10.25	.28	.02	9
TOTAL								158

*S = variance